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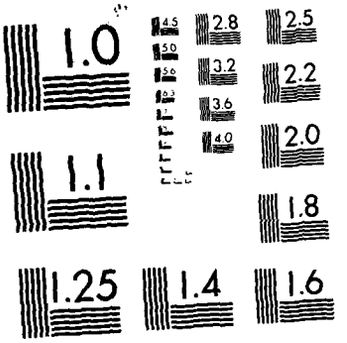

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THE NAVY OFFICER FORCE PROJECTION (OPRO) MODEL

NAVY PERSONNEL RESEARCH
AND
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San Diego, California 92152

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THE NAVY OFFICER FORCE PROJECTION (OPRO) MODEL

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The officer force projection (OPRO) model is an inventory projection technique embedded in the structured accession planning system for officers (STRAP-O). Using predictions of personnel flow rates, a starting inventory is successively projected (by year) into the future. This allows a manager to assess the feasibility of manpower goals, test the sensitivity of the force to policy changes, and develop promotion and accession plans. This report describes the structure and mechanics of the OPRO model and illustrates its capabilities with serveral applications.

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FOREWORD

This research and development was conducted in response to Navy decision coordinating paper Z1187-PN (Computer-based Manpower Planning and Programming) under subproject PN.02 (Officer Personnel Management Models) and was sponsored by the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) (OP-01). The objective of this subproject is to develop a set of user-oriented, computer-based models and data bases to assist in the development of a Navy officer force that meets the requirements for officer manpower.

This report describes a major component of the structured accession planning system for officers (STRAP-0)--the officer force projection (OPRO) model. The OPRO model is a force projection model currently used by OP-01 to assess the feasibility of future officer manpower plans, test the sensitivity of the officer force to policy changes, and develop promotion and accession plans.

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SUMMARY

Problem

The Navy's officer manpower managers are faced with the task of balancing a dynamic supply of commissioned and warrant officers with an equally dynamic demand for their services. Their job is complicated by the complexity of personnel flows through the Navy's officer personnel system, the unstable nature of the system's manpower requirements, and the continuing shortages of critical skills. An understanding of these flows (and their constraints) and how they assist or prevent the manager from matching personnel resources with requirements, as well as the ability to forecast them accurately under alternative policies, are essential ingredients to successful force management. This capability is currently being provided by the officer force projection (OPRO) model.

Objective

The purpose of this report is to describe the structure, mechanics, and applications of the OPRO model.

Structure and Mechanics

The officer force projection (OPRO) model describes the officer personnel system in three dimensions: community, pay grade, and length of service. Most of the variables in the OPRO model, which constitute the flows through the personnel structure, are similarly dimensioned. For each community, the model generates successive annual end strength projections using a variety of predicted and/or manager-supplied personnel flows. In addition, a summary report provides other force parameters, including promotion flow points and opportunities and predicted losses and gains.

Applications

The OPRO model can be employed in a number of ways on a recurring basis, including assessing the feasibility of manpower goals, constructing "zones of executability," developing promotion plans, and analyzing policy changes or special programs. To date, it has been used to assess the personnel system's ability to man a 15 battle-group Navy by 1990, to develop the FY84 promotion plan, and to construct out-year force structure under a variety of retention scenarios for the Fifth Quadrennial Review of Military Compensation.

Conclusions

The OPRO model is a "living" model with modifications underway to improve its accuracy and expand its capabilities. If history is any indication, the officer personnel system will undergo numerous changes in its structure. To preserve the integrity and accuracy of the OPRO model in the face of these changes, model enhancements are an ongoing enterprise.

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INTRODUCTION

Problem

The officer manpower manager is faced with the task of balancing a dynamic supply of commissioned and warrant officers with an equally dynamic demand for their services. The complexity of personnel flows through the Navy's officer personnel system, the unstable nature of the system's manpower requirements, and continuing shortages of critical skills contribute to the difficulty of this job. The manager is perhaps most concerned with the personnel flows that affect the size of the force (e.g., losses and gains) and its internal structure (e.g., promotions and lateral transfers). An understanding of these flows (and their constraints) and how they assist or prevent the manager from matching personnel resources with requirements, as well as the ability to forecast them accurately under alternative policies or with guidance from different sources, are essential ingredients to successful force management.

This capability is currently provided to managers in the offices of the Deputy Chief of Naval Operations (Manpower, Personnel, and Training) by the officer force projection (OPRO) model, a member of a class of manpower models known as "fractional flow" models. Using predictions of personnel flow rates, a starting inventory is successively projected (usually by year) into the future. This provides the manager with the ability to assess the feasibility of manpower goals, test the sensitivity of the force to policy changes, and develop promotion and accession plans.

Objective

The purpose of this report is to describe the structure and mechanics of OPRO and illustrate its capabilities with several applications.

Background

The structure of the Navy's officer personnel system can be characterized by the way some 67,000 officer personnel are classified. This structure arranges all personnel in 3 dimensions: (1) 23 occupational specialties known as "communities," (2) 9 pay grades (PG), which represent levels of skills and authority, and (3) 31 length-of-service (LOS) categories defined as years of commissioned service (YCS).

The personnel structure is affected by five kinds of personnel flows: gains, losses, and three types of movement within the force structure. These flows are described below:

1. Gains--flows into the officer force, which can be classified by their source (e.g., the reserve inventory, the enlisted force, the officer force at a previous point in time (denoted as "recalls"), and the civilian labor force).

2. Losses--flows out of the officer force, which can be classified by their destination--either terminal losses to the civilian labor force or losses from the active duty inventory to the reserve inventory.

3. Advancements along the pay-grade dimension, which are achieved through promotions. Because the officer personnel system is a nearly closed organization, vacancies are normally filled through internal promotion from the grade below.

4. Transfers from other communities (laterals), which are closely monitored by the manpower planners. For a single community, it is possible to have laterals flowing both in and out.

5. The flow of personnel along the LOS dimension ("aging"), which occurs as the amount of accumulated time in service increases.

The officer personnel system is motivated by requirements for manpower. "True" requirements, unconstrained by budget considerations, are issued routinely for the next 5-7 years. Delineated by grade and community, these requirements are a function of the size and configuration of the fleet, the missions the fleet is expected to undertake, the support workload (e.g., shipyards, supply centers), and the manpower overhead (e.g., trainees, transients) necessary to sustain the operating units.

In the near term (1-2 years out), requirements are limited by the manpower budget appropriated by Congress. The resulting "authorized strengths" represent the goals of the personnel system. As stated earlier, the manpower manager must then steer the force structure toward those goals by affecting personnel flows.

STRUCTURE AND MECHANICS

Structure of the OPRO Model

The OPRO model describes the officer personnel system in three dimensions. The basic processing unit is a personnel force structure, an array of personnel classified by pay grade and LOS. Most of the variables in the OPRO model, which constitute the flows through that structure, are similarly dimensioned and are represented by 32 x 10 matrices. The 32 rows correspond to the 31 LOS intervals and their total; and the 10 columns, to 6 due-course pay grades, 3 fail-select "grades," and total pay-grade vector summed over the LOS rows.

Each variable is identified for 23 officer communities, plus an aggregate matrix that is the sum of all the communities. The communities are listed in Table 1. Under current regulations, the five unrestricted line (URL) communities are managed as a group, subject to a common set of promotion policies, while each of the restricted line (RL), staff corps, and limited duty communities are managed separately, subject to unique promotion policies. Consequently, OPRO models the officer personnel system as 19 distinct "mini-Navies": 1 URL, 7 RL, 8 staff corps, and 3 limited duty.

Manpower Accounting--The Mechanics of an OPRO Forecast

For each community, the OPRO model generates seven successive annual end strength projections from a beginning inventory using a variety of predicted and/or user-supplied personnel flows. These flows, which include accessions, promotions, losses, and aging, are influenced by promotion policy parameters, pay-grade targets, compensation, Defense Officer Personnel Management Act (DOPMA) restrictions, and managerial overrides.

Table 1

Communities of the Navy Officer Personnel System

Community Name	Designator(s)
Unrestricted Line	
Generalists	110X
Surface warfare officer	111X, 113X, 114X, 116X, 118X, 119X
Submarine warfare officer	112X, 117X
Aviator warfare (pilot)	131X, 139X
Aviation warfare (naval flight officer) (NFO)	132X, 137X
Restricted Line	
Engineering duty officer (EDO)	14XX
Aeronautical engineering duty officer (aeronautical engineering) (AEDO)	151X
Aeronautical engineering duty officer (aviation maintenance) (AMD)	152X
Special duty officer (cryptology)	161X
Special duty officer (intelligence)	163X
Special duty officer (public affairs)	165X
Special duty officer (geophysics)	180X
Staff Corps	
Medical	210X
Dental	220X
Medical service	230X
Judge advocate general's	250X
Nurse	290X
Supply	310X
Chaplain	410X
Civil engineer	510X
Limited Duty	
Line	61XX, 62XX, 63XX, 64XX
Staff (Supply)	651X, 652X
Staff (Civil engineer corps)	653X
Total Navy	All designators (less commissioned warrant officers (line and staff)

For each fiscal year, the OPRO model performs numerous operations that satisfy a manpower accounting equation:

$$I_{i,j+1,k}(t) = I_{ijk}(t-1) - L_{ijk}(t-1,t) + G_{ijk}(t-1,t) - P_{ijk}(t-1,t) + P_{i-1,jk}(t-1,t) + P_{i-2,j,k}(t-1,t)^{1}$$

where

$I_{ijk}(t)$ = Population in grade i, year of service j, and community k, at the end of period t,

$L_{ijk}(t-1,t)$ = Losses from $I_{ijk}(t-1)$ during period (t-1,t),

$G_{ijk}(t-1,t)$ = Gains to $I_{ijk}(t-1)$ during period (t-1,t),

$P_{ijk}(t-1,t)$ = Promotions from grade i, during period (t-1,t), and

i = Pay grade (i-1, 2,...9),

j = Length of service (j = 0, 1,...30),

k = Community (k = 1, 2...24).

This basic form is complicated by (1) the need for user control of certain flows (e.g., loss overrides), (2) the variety of policy-sensitive flows subsumed under L_{ijk} and G_{ijk}, and (3) the necessary but complicated process used to derive promotions.

Processing within the OPRO model is sequential, starting with the initial inventory of personnel at the beginning of a fiscal year. This inventory provides the basis for calculating losses. Losses are derived by:

$$L_{ijk}(t-1,t) = r_{ijk} \cdot I_{ijk}(t-1)$$

where r_{ijk} is a loss rate, $0 \leq r \leq 1$.

Loss rates are provided to the OPRO model by an external subroutine that utilizes historical loss rates and pay elasticities to generate a forecast. For each community, the loss rates include strength losses (e.g., resignation, retirement), as well as losses to a community in the form of lateral transfers. In addition, the user has the capability to override the losses predicted by the OPRO model.

Like losses, gains are of two types--new accessions or prior service gains (additions to strength) and lateral transfers. When making a URL force projection, the user must supply the OPRO model with all new accessions and prior service gains by pay grade for each of the five URL communities. Lateral transfers are computed from historical rates.

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[1]Promotions to grade i are made from the next lowest due course pay grade (P_{i-2}) and its fail select components (P_{i-1}). For example, promotees to commander (O-5) come from lieutenant commander-fail select (O-4F).

For restricted line, staff corps, and limited duty communities (hereafter referred to as RL/staff corps), the user either supplies all gains or they are determined as the gains necessary to achieve a desired total community end strength. The gains are spread by pay grade and LOS over the inventory according to historical patterns. A "dividing line" is used to segregate the gains into new accessions and others, including prior service gains and lateral transfers. For both the URL and RL/staff corps communities, new accessions are added to the inventory at the end of the year, while "other gains" are added at the beginning of the year so as to be eligible for promotion during that year.

Movement along the pay grade dimension from O-4 through O-6 is controlled by the user's specification of promotion policy. Promotions to O-2 and O-3 occur automatically at 2 and 4 years of service, respectively, with 100 percent opportunity. Promotions are regulated by three key factors: a prescribed number of officers in a grade (strength target), the promotion zone, and the promotion opportunity. In the OPRO model, two of these factors must always be specified. For example, if strength targets and opportunities are given, OPRO will determine the due-course promotion zone necessary to meet the target. Similarly, the overall opportunity for a grade will be determined if strength targets and promotion zones are identified. Finally, if both an opportunity and a zone are specified, the OPRO model will derive the resulting grade strength. The OPRO model also allows "deep select" and "late select" promotions to be made. This is done by supplying the percentage of total promotions to be granted to personnel above and below the due course zone. After all other flows have been accounted for, the OPRO model "ages" those onboard to the next highest LOS cell to produce the end-year inventory.[2]

Using the OPRO model, the manager has the capability to shape the force by manipulating a set of inputs. Those inputs are listed in Table 2, along with their primary and secondary effects on personnel flows.

Table 2

OPRO Model Inputs

Input	Primary Variable(s) Effected	Secondary Effects
Pay changes	Losses	Promotion parameters, end strength
Loss overrides	Losses	Promotion parameters, end strength
Accessions	End strength	Promotion parameters
Strength targets	Promotion parameters	Flowpoints[a]
Promotion opportunity	Promotion zone	Flowpoints[a]
URL community promotion opportunities[b]	Share of URL promotions[b] to each community	

[a]Refers to the average LOS of promotees at time of advancement.

[b]Applicable only to URL communities.

[2]New accessions (no prior service) are added to the force after the aging process. Because they enter the force during the year, they have not completed a year's service by the year's end.

APPLICATIONS

The primary role of the OPRO model is to produce a consistent and detailed forecast of future officer populations and the contributing personnel flows. This capability is employed in a number of ways on a recurring basis, including assessment of the feasibility of manpower goals, construction of "zones of executability," development of promotion plans, and the analysis of policy changes or special programs.

As part of the STRAP-O system, the OPRO model is instrumental in determining whether a desired force of officers is achievable in terms of various factors. These factors include expected or desired retention, the number and types of accessions required, and promotion and lateral transfer plans needed. For a specified set of personnel policies, STRAP-O projects strengths that can be readily compared to manpower goals. If the goals are attainable, then a personnel plan has been generated for further evaluation (e.g., for cost). If the goals are unattainable, the OPRO model can be used to diagnose the causes of the infeasibility and allow the manager to test policy changes that would make the goals achievable.

A recent application of this capability was an assessment of the personnel system's ability to man a Navy represented by 15 battle groups by 1990. Figure 1 shows that the goals can be met in terms of total force strength by 1988. This forecast is based on the assumptions that accession levels and promotion parameters would remain at their FY82 values and that pay raises beyond FY82 would at least keep pace with inflation. The latter assumption implies an optimistic level of retention.

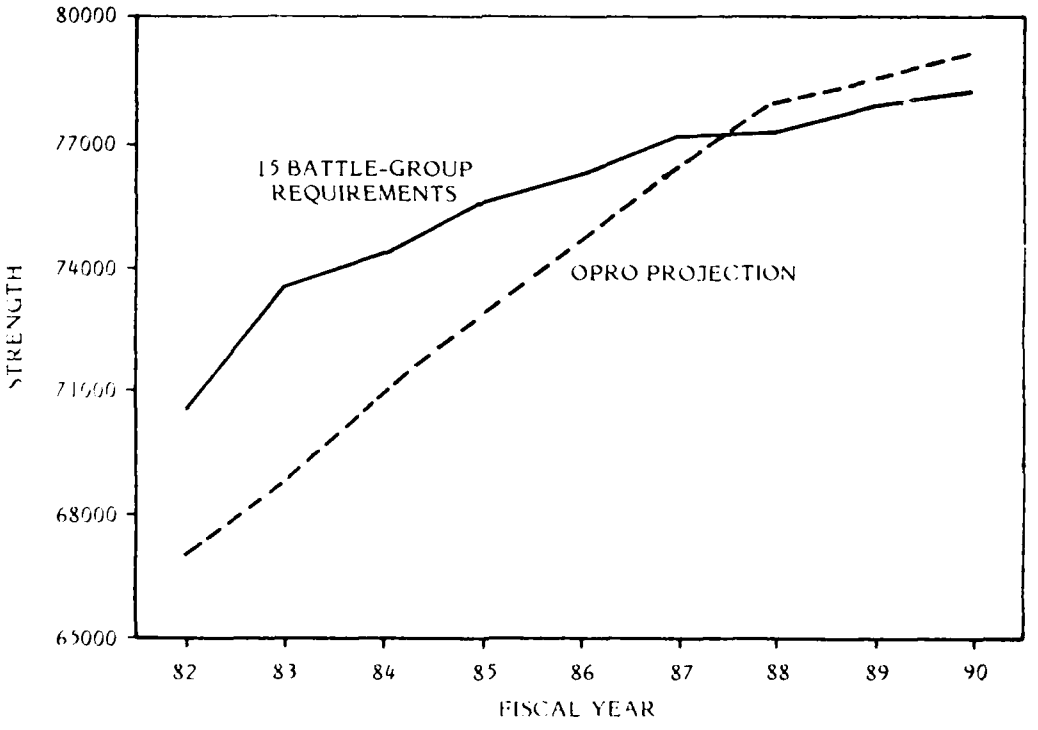

Figure 1. 15 battle-group (by 1990) scenario: OPRO model projection vs. requirements.

Although it appears that the total force goals can be met, this reveals nothing about the status of individual communities or pay grades. By making community-specific projections (by pay grade and LOS), the OPRO model helps identify shortages and overages and permits manipulation of personnel flows at those levels of aggregation.

A second application of OPRO involves the construction of "zones of executability" (ZOEs). ZOEs establish maximum and minimum achievable force sizes from a variety of policy scenarios reflecting Navy, DoD, and Congressional guidance. A typical ZOE, shown in Figure 2, held accession and promotion policies at FY82 levels across the 5-year projection, varying only retention. Estimates of loss behavior range from very optimistic (Scenario 3) to somewhat pessimistic (Scenario 1). The force, however, is not likely to operate at either extreme but, instead, somewhere in between (Scenario 2).

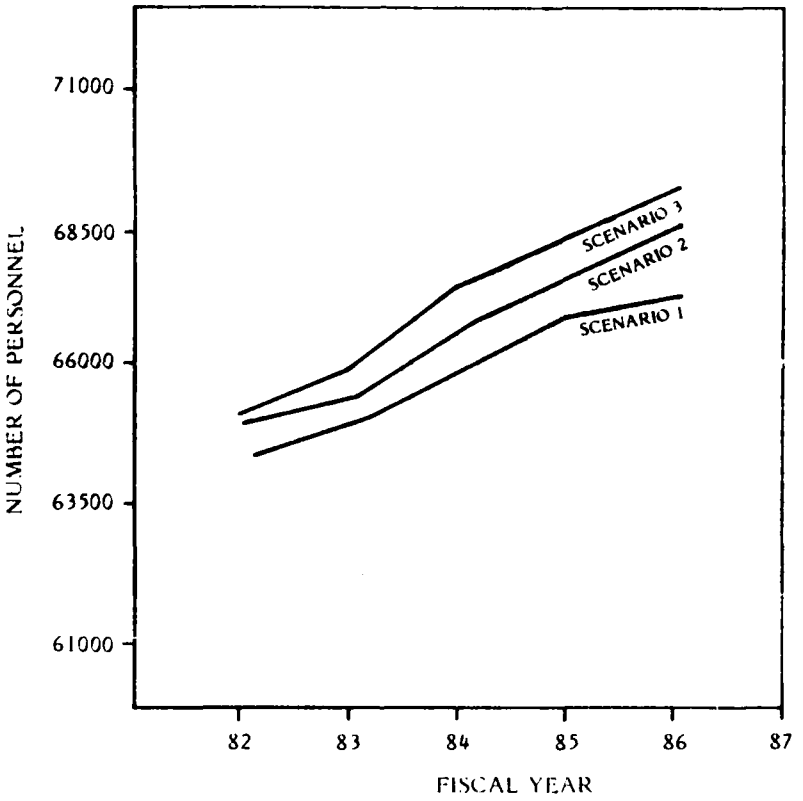

Figure 2. Example of zones of executability (ZOE).

The OPRO model is also useful for evaluating the effects of a set of policy alternatives or to identify alternatives to existing policies. An example would be evaluation of the impact of proposed pay raises for a particular fiscal year. The initial impact, changes in losses for the URL, for a 4 percent, 0 percent, and -4 percent real (above inflation) pay raise is displayed in Table 3. This table shows that losses from higher pay grades (e.g., O-5 and O-6) are generally not affected by such small pay variation, but that mid-grade officers (O-3, O-4) are more vulnerable. These changes in losses result in changes in total end strength, grade strengths, the distribution of personnel by community, the promotion flow, and, ultimately, the cost of the force.

Table 3

URL Losses by Pay Grade Under Alternative Pay Scenarios

Pay Raise	Pay Grade					
	O-1[a]	O-2[a]	O-3	O-4	O-5	O-6
-4%	607	742	1578	600	365	297
0%	607	742	1512	590	365	297
4%	607	742	1450	583	365	297

[a]Because virtually all O-1s and O-2s are under initial contracts, they are not eligible to make a voluntary stay/leave decision influenced by pay.

Finally, the OPRO model can assist in the development of promotion plans. A promotion plan includes the number of officers to be promoted, promotion opportunity to be offered, and the resulting flow point. Because selection boards convene during the fiscal year preceding the year in which the promotion will be made, the promotion plan must be generated over a year in advance. This necessitates a projection capability like that found in the OPRO model. A typical OPRO exercise is to fix promotion opportunity (to reflect organizational guidance) and then vary losses to determine the variation in the number of promotions to be made, the zone size, and the resulting flow points.

The OPRO model has also been used to explore the sensitivity of promotion zones relative to promotion opportunities. With all input parameters held constant (including losses and grade targets), promotion opportunities were varied to determine the responsiveness in zone sizes. Assuming that the top of the O-4, O-5, and O-6 promotion zones for FY83 are 8.65, 14.75, and 20.83 years of service respectively, Table 4 shows the results of varying promotion opportunities over a 10-percent range. The movement in the bottom of the zone (and hence the overall zone size) measures the effect of the variable opportunity.

Table 4

Sensitivity of Promotion Zones With Respect to Promotion Opportunity

Item	Years of Service (Opportunity)		
	O-4	O-5	O-6
Top of zone	8.65	14.75	20.83
Bottom of zone	7.78 (95%)	13.82 (80%)	19.87 (60%)
	7.73 (90%)	13.78 (75%)	19.78 (55%)
	7.68 (85%)	13.72 (70%)	19.69 (50%)

Note that the number of promotions being made does not change; hence, for a declining opportunity, more officers must be included in the zone to make the necessary promotions. For example, for promotions from O-3 to O-4, a 95 percent opportunity implied including the top 22 percent (1.00 - 0.78 = 0.22) of year-group 8 ($7 \leq LOS < 8$). If the opportunity was lowered to 90 percent, then 27 percent of the year-group would be included in the zone and so on. The "elasticity" of zone size with respect to opportunity for O-4s in this example is roughly 1.0. A 1-percent decline in opportunity results in a 1-percent increase in the zone size. In the scenario, the elasticities for O-5 and O-6 are approximately 1.0 and 1.8 respectively. While these elasticities are unique to a particular promotion scenario (a set number of advancements), they are useful for comparing variations in parameters within that scenario. A similar statistic, the responsiveness of opportunity with respect to zone size, can also be computed.

CONCLUSIONS

The OPRO model is a detailed mathematical representation of the Navy's officer personnel system intended to produce accurate forecasts of future officer populations and their contributing personnel flows. Managers are provided with the ability to assess the feasibility of manpower goals, test the sensitivity of the force to policy changes, and develop promotion and accession plans.

The OPRO model is a "living" model with modifications underway to improve its accuracy and to expand its capabilities. If history is an indication, the officer personnel system will undergo numerous changes in its structure (e.g., community and flow variable definitions). To preserve the integrity and accuracy of the OPRO model, enhancements must be an ongoing enterprise.

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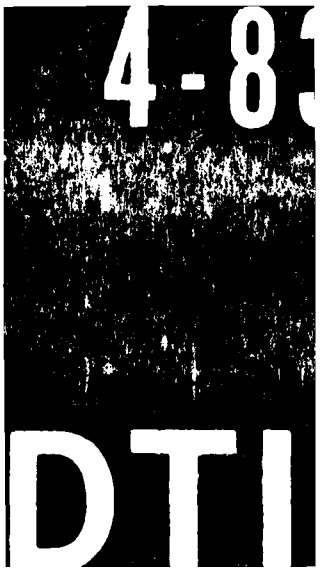
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